UNIVERSITY OF WYOMING REMOTE SENSING LABORATORY

TYPE I PROGRESS REPORT

CONTRACT NAS5-21818

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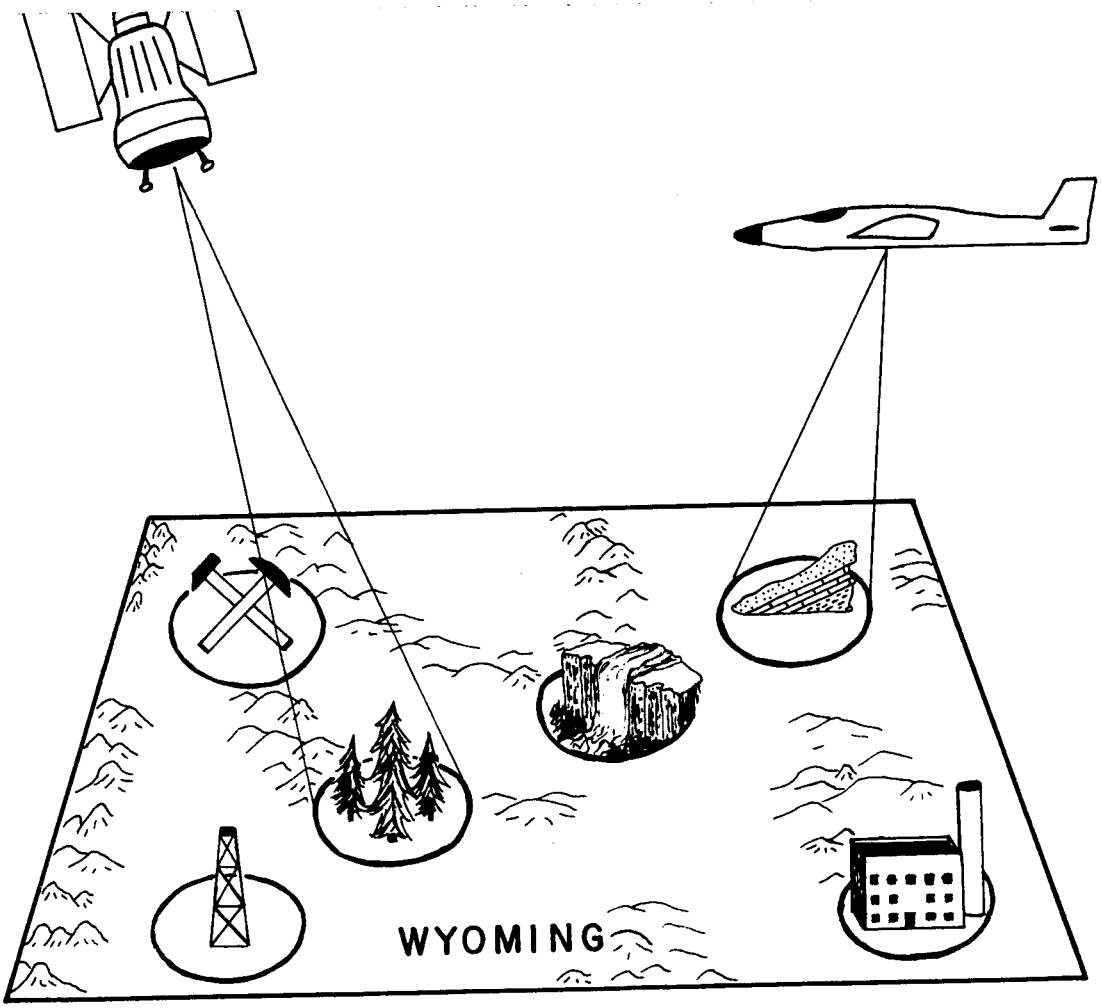

TYPE I PROGRESS REPORT (Contract NAS5-21818)

COOPERATIVE PROPOSAL TO STUDY THE GEOLOGY OF A TEST SITE IN THE ICE-FREE VALLEYS OF ANTARCTICA

SHORT ABSTRACT

Preliminary study of ERTS images of the Ice-Free Valleys of Antarctica indicates that color-additive viewing is useful in the study of geologic contacts and in bringing out details of structure in glaciers. In this vegetation free area, contacts between mafic rocks (Ferrar Dolerite) and felsic rocks (Irizar Granite) are well defined on MSS-7, and can be enhanced by using a combination of MSS-4 and MSS-7. Details of flow structure in glaciers are also best shown on MSS-7 and this structure can also be enhanced by use of combinations of either MSS-4 and MSS-7 or MSS-5 and MSS-7. The strong contrast in MSS-7 between mafic and felsic rocks may result from differences in reflectance in rocks with major variations in ferrous iron as suggested by Rowan (1972). The marked darkening and increase in structural detail of snow-free glaciers from MSS-4 to MSS-7 may be caused by the presence of water on ablating glaciers and may be similar to processes suggested by Strong, McClain amd McGinnis (1971) who suggest that melting conditions on the surface of frozen Lake Winnipeg result in enough absorption of radiation to make the surface appear dark in the near IR.

INTRODUCTION

In the past several weeks we have received our first images of Antractica. The images received were in areas adjacent to, but not including, the Ice-Free or Dry Valleys of Antarctica which is the test site for this project. Last week (Feb. 12-16th) we received an image of the Dry Valleys proper and it is excellent. We have begun study of the Dry Valley image and have also

started other related work that will be described below.

OBJECTIVE

The objective of this study is to determine what type of geologic information can be obtained from ERTS images in a vegetation-free area such as the Dry Valleys. If geologic mapping is possible we will construct a geologic map by use of images.

WORK PERFORMED

All necessary preparation for data analyses has been completed as part of the Wyoming Project (NAS5-21799) and preparation for study of the Antarctic imagery began in January 1973. Mr. Frank Zochol, graduate student at the University of Wyoming, began work on this project in January 1973 and is currently compiling a geologic map of the Dry Valleys from mapping done by staff and students at the University of Wyoming and from the literature. This map will be used as a base map for ground truth. With the receipt of imagery from the Dry Valleys (week of February 12th, 1973), we have begun a preliminary study of the imagery.

PRELIMINARY REPORT ON DRY VALLEY IMAGERY

Preliminary study of the Dry Valley image suggests that certain of the geologic units can be mapped using ERTS-1. For example, contacts between the Irizar Granite and Ferrar Dolerite are shown in great detail in Victoria Valley, and it seems that contacts between various other rock types can be resolved in areas of relatively low relief. Unfortunately extensive areas of low relief are not typical of the Dry Valleys where most of the exposed rock is in U-shaped glacial valleys with a relief in excess of two miles from valley floor to interglacial divides.

This means that stereo coverage is needed to extract a maximum amount of information from the images. We have stereo coverage (from side lap) of one small section of the Dry Valleys but not for most of the areas. Inasmuch as side lap should be excellent in this area, we anticipate receiving images that will allow stereoscopic viewing (Jan. 12 and 14).

Examination of the four ERTS bands indicates that geologic contacts between felsic and mafic rocks (i.e. Irizar Granite and Ferrar Dolerite) are most clearly defined on band 7 and this band appears best for study of other rock types, as well. In addition, band 7 shows details of flow structure in glaciers much better than in any of the other bands. The amount of detail that can be seen in glaciers increases progressively from band 4 to band 7. The contrast between the reflectivity of two lakes, Vida of Victoria Valley and Vanda of Wright Valley, is instructive in this regard.

Lake Vida and Lake Vanda are perennially ice-covered. Vanda is a stratified lake with fresh water at the top and saline water at deeper levels, and Vida is probably similarly stratified (at least, melt water at its margins is potable in the summer). Both of these lakes thaw somewhat in the Antarctic summer (Dec. 15-Jan. 15th is perhaps the optimum time) and develop a moat of meltwater around their margins up to 12 meters in some areas. Meltwater from glaciers flows into the lakes and adds to the water around the margin of the lakes. Study of images shows several streams of meltwater entering Lake Vida but there is no evidence of meltwater entering Lake Vanda. Lake Vida shows light tonal shades in band 4 and becomes progressively darker, expecially at its margins, until it is almost as dark as sea water in band 7. Lake Vanda shows a slight tonal darkening from band 4 to 7 but it is about the same as shown by the glaciers.

This appears to be an excellent example of the value of the multiband approach in detecting the presence of water. The progressive darkening of Lake Vida from band 4 to band may reflect the strong absorption of the infrared by water, and the fact that the glaciers and frozen lakes also show a perceptible darkening suggests that although these bodies of ice have not begun to thaw extensively they may begin a process of ablation (melting and evaporation) during the Antarctic summer and this moisture may be the cause of the marked tonal darkening in band 7. In fact, our observations at the Shelton Glacier of Antarctica in late December of 1969 suggest that ablation does indeed take place at this time. This process is apparently similar to that described by Wiesnet and McGinnis (1972) who discuss the determination of thawing snow and ice using satellite data.

It is tempting to suggest that moisture content of rocks may play a role in bringing out contrasts between felsic and mafic rocks in band 7, but we have no evidence that these rocks vary in moisture content and there is considerable evidence (Rowan, 1972; Vincent, 1972), that mafic rocks (rocks rich in iron) show a decrease in reflectance in the near infrared and felsic rocks (poor in iron) show an increase in reflectance. Examination of the images shows that the mafic rocks (Ferrar, Dolerite) are indeed distinctly darker in band 7 and show a progressive darkening from band 4 to 7. Changes in reflectance of the felsic rocks (Irizar Granite) are not so apparent from visual inspection of images, but the Irizar Granite does appear lighter in tone (higher reflectance) in band 7.

Color-additive analysis and ratioing techniques should be successful when contrasts of the type discussed above are shown by bodies of rock, lakes,

and glaciers in the various ERTS bands. Preliminary study of the Dry Valley images suggest that color-additive viewing can be used to enhance both geologic contacts and features of the lakes and glaciers. For example, band 4 (blue filter) combined with band 7 (no filter) shows the contact between the Irizar Granite and Ferrar Dolerite with strong contrast between the mafic and felsic units. Visually the contact appears to be better defined than in band 7 alone. In addition, this band combination shows the apparently snow free and possibly ablating portions of the glaciers and Lake Vanda in light blue and Lake Vida (lake with more melt water) in dark blue, and again appears to give a better enhancement than using band seven alone.

A combination of band 5 (displayed in red) and band seven (displayed in green) also shows a distinct enhancement of the snow free and/or ablating glaciers in shades of deep pink and a deep red for Lake Vida. This band brings out contrasts in felsic units such as Irizar Granite and Larsen Granodiorite, but they are subtle and may be no better than shown in band 7 alone except perhaps for a greater esthetic appeal of the colored image.

We expect to continue study of the Dry Valleys by working first with those areas where we have stereo coverage and where we can undertake more accurate mapping of the geology.

This first look at the Antarctic imagery is encouraging and we hope to be able to prepare a special report on the geology and other features of glaciology noted in this area sometime this Spring.

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